DIFFERENTIAL IRRADIATION RECORDS IN THE H6 CHONDRITE ALH76008: EVIDENCE FOR A NEBULAR ORIGIN OF A CHONDRULE-LIKE INCLUSION ? E. Polnau[1], O. Eugster[1], U. Krähenbühl[2], and K. Marti[3], [1] Physikalisches Institut, University of Bern, CH-3012 Bern, Switzerland, [2] Anorganisch chemisches Institut, University of Bern, CH-3012 Bern, Switzerland, [3] University of California at San Diego, La Jolla CA 92093-0317, USA.

We present noble gas and chemical data of bulk material, several mineral separates, and a spherical inclusion (chondrule-like) from the H6-chondrite ALH76008 [1]. The diameter of the "chondrule" is about 3mm and its weight is 13mg. Bulk matrix material was separated into a Fe,Ni fraction and magnetic and non-magnetic silicates . These silicates were further separated into material above and below a density of 2.9g/cm^3. The objective of this work is the study of the cosmic-ray exposure history of these chondrite constituents. For the inclusion we observe a longer cosmic-ray exposure time, when compared to the matrix samples. This evidence suggests an exposure of the inclusion or of parts thereof before it was incorporated into the matrix of the chondritic material. A probable scenario for the origin of this inclusion is accretion from the nebula. Table 1 gives the results of He, Ne, and Ar analyses and Table 2 the noble gas components.

The production rates for the cosmogenic ^{3}He, ^{21}Ne, and ^{38}Ar were derived based on the method proposed by [2]. This method requires the knowledge of the chemical composition of the various chondrite phases; these were analyzed using ICP mass spectrometry (Table 3).

Inspection of the cosmic-ray exposure ages (Table 2) shows that the inclusion was exposed to cosmic rays (adopting constant cosmic-ray intensity) for about 1 Ma longer than the matrix constituents. This result is of interest with regard of the question whether chondrules formed in the solar nebula or on the surface of a parent asteroid. Regolith models can be constructed in which chondrules formed on a planetary body and were differentially irradiated by cosmic rays and then incorporated into a matrix material. Another more probable scenario is the exposure of the chondrule or of components thereof in the nebula before it was accreted by a planetary object and was incorporated into material that did not experience such an exposure. The cosmic-ray exposure of the chondrite as a whole occurred when it was launched from its parent body on it's journey to Earth that lasted 1.5 ± 0.5 Ma (Table 2).

Additional information on the irradiation records is found in the siting of trapped solar gases in ALH76008. The magnetic fraction of density ≤ 2.9 gcm^{-3} yields a relatively large concentration of trapped solar gases (Table 2) with a ratio $(^{20}Ne/^{22}Ne)_{tr}=12.3 \pm 0.3$ (Figure 1). This ratio is typical for a mixture of solar wind- and SEP-Ne [3]. We do not know the distribution of grain sizes of the various mineral fractions; the loading by solar particles might indicate a strong grain size effect. Alternatively, components of the magnetic fraction (≤ 2.9 gcm^{-3}) experienced a longer exposure to solar particles. Therefore, differential irradiation records for solar and cosmic radiations are observed in this H6 chondrite.

We continue this work by preparing chondrule separates from other chondrites in order to study the question whether a pre-exposure of chondrules relative to matrix material is a common feature.

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References: [1] Olsen E.J. et al. (1978) Meteoritics 13, 209. [2] Eugster O. (1988) GCA 52, 1649. [3] Geiss J. (1973) Proc. 13th Intl. Cosmic Ray Conf. 5, 3375. Wieler R. et al. (1986) GCA 50, 1997.

Table 1. ALH 76008: Results of He, Ne, and Ar measurements

Sample	Weight (mg)	^{4}He	^{20}Ne	^{40}Ar	^{4}He/^{3}He	^{20}Ne/^{22}Ne	^{22}Ne/^{21}Ne	^{36}Ar/^{38}Ar	^{40}Ar/^{36}Ar
		[$10^{-8}cm^3STP/g$]							
Bulk	22.23	620	1.12	4430	354	1.351	1.104	[2])	[2])
Fe,Ni	24.32	238	0.485	2227	175	0.920	1.041	[2])	[2])
Magn., $\leq 2.9gcm^{-3}$	21.55	857	11.70	5452	579	6.941	2.167	[2])	[2])
Magn., $> 2.9gcm^{-3}$	24.41	638	0.779	4050	382	0.945	1.073	[2])	[2])
Magn., $> 2.9gcm^{-3}$	1527.3	[1])	[1])	3400	[1])	[1])	[1])	4.101	3593
Non-magn., $\leq 2.9gcm^{-3}$	23.76	1784	0.790	7053	719	0.881	1.062	[2])	[2])
Non-magn., $> 2.9gcm^{-3}$	22.68	1960	1.43	5589	689	1.436	1.093	[2])	[2])
Chondrule	8.00	1628	1.07	8705	478	0.856	1.046	2.906	13804

Typical experimental errors (2σ mean) are 5% (concentrations), 1-2% (^{22}Ne/^{21}Ne), 15% (Ar-ratios), 1-5% (other ratios). [1]) Not analyzed. [2]) No data due to analytical problems for small samples.

Table 2. Cosmogenic and trapped noble gases and exposure ages

Sample	Cosmogenic ^{3}He	Cosmogenic ^{21}Ne	Cosmogenic ^{38}Ar	Trapped ^{20}Ne	Trapped ^{36}Ar	T_3	T_{21}	T_{38}	T_4	T_{40}
	[$10^{-8}cm^3STP/g$]			[$10^{-8}cm^3STP/g$]				[Ma]		
Bulk	1.75	0.749	-	0.49	-	1.10	1.77	-	1978	4280
Fe,Ni	1.36	0.506	-	0.067	-	-	-	-	-	-
Magn., $\leq 2.9gcm^{-3}$	1.48	0.747	-	11.07	-	0.88	1.91	-	-	-
Magn., $> 2.9gcm^{-3}$, ($24.41mg$)	1.67	0.768	0.072	0.12	-	1.00	1.76	1.62	-	3706
Magn., $> 2.9gcm^{-3}$, ($1527.3mg$)	-	-	0.060	-	0.907	-	-	1.35	-	3434
Non-magn., $\leq 2.9gcm^{-3}$	2.48	0.845	-	0.077	-	1.48	2.05	-	-	(5847)
Non-magn., $> 2.9gcm^{-3}$	2.84	0.907	-	0.68	-	1.65	1.95	-	-	4427
Average matrix						1.22	1.89	1.49		
Chondrule	3.41	1.19	0.118	0.074	0.578	2.16	2.93	2.11	-	-
Errors (2σ mean)	5%	5%	20%	5-20%	25%	5%	15%	30%	12%	12%

Table 3. Chemical concentrations

Mineral fraction	Mg	Al	Si	K	Ca	Ti	Fe	Rb	Sr	Y	Zr	Ba	La
	%							ppm					
Bulk	14.2	0.69	-	0.065	0.54	-	28.6	-	9.5	2.0	3.09	1.31	0.31
Magn., $\leq 2.9gcm^{-3}$	10.8	1.25	26.5	-	3.4	0.063	13.0	7.8	17	2.8	10.1	15	-
Magn., $> 2.9gcm^{-3}$	13.2	1.15	25.0	0.085	1.25	0.057	15.2	6.1	9.3	1.7	9.5	36	-
Non-magn., $\leq 2.9gcm^{-3}$	11.8	1.05	27.0	0.041	1.0	0.026	14.3	4.1	6.8	3.4	0.97	14	-
Non-magn., $> 2.9gcm^{-3}$	13.8	0.90	28.7	0.075	1.78	0.024	8.29	7.4	11	1.8	9.4	20	-
Chondrule	13.7	2.32	12.4	-	1.2	0.164	30.0	16	80	6.0	77	130	-

Errors (2σ mean) are 10-20%

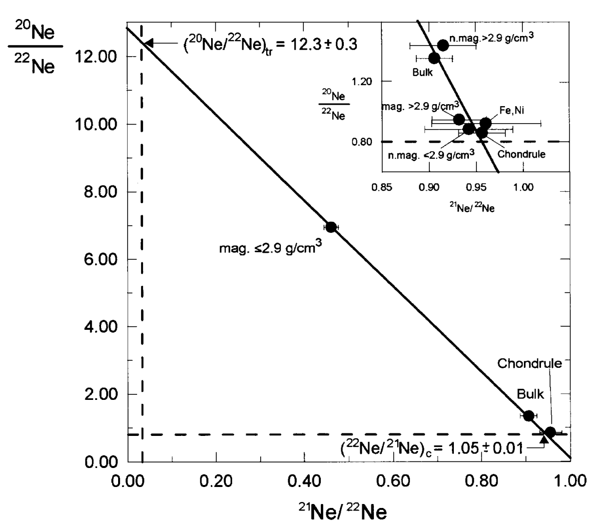

Fig. 1. The 20Ne/22Ne vs. 21Ne/22Ne diagram of the samples from ALH76008 gives a ratio (20Ne/22Ne)tr = 12.3 ± 0.3.